J. DAVIDSON, Jr.

SIGNALING CIRCUITS FOR TOLL LINES.

APPLICATION FILED DEC. 12, 1918.

1,429,931.

Patented Sept. 26, 1922.

8 SHEETS—SHEET 1.

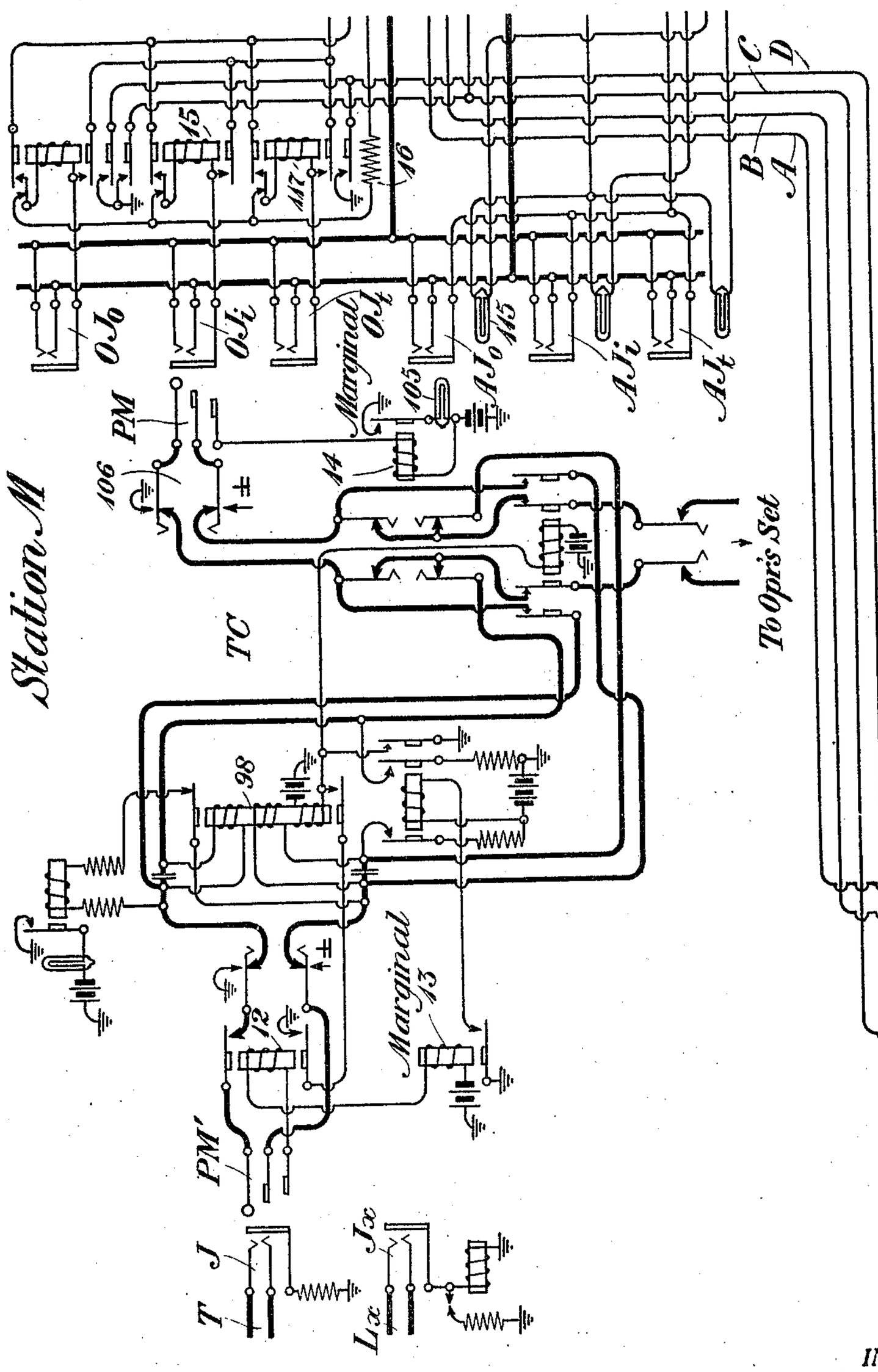

Fig. 1

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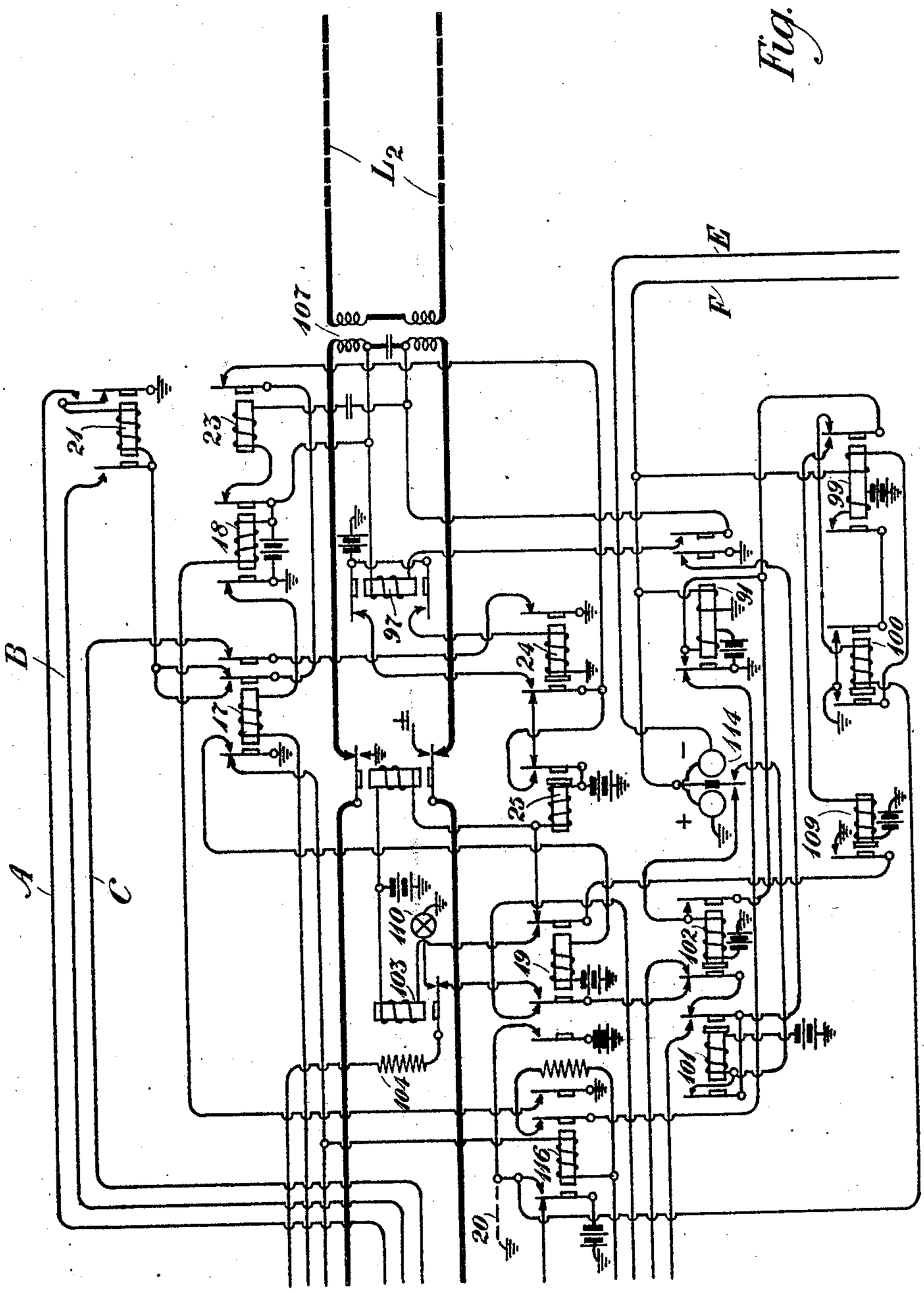
8 SHEETS—SHEET 2.

Fig. 2



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8 SHEETS—SHEET 3.

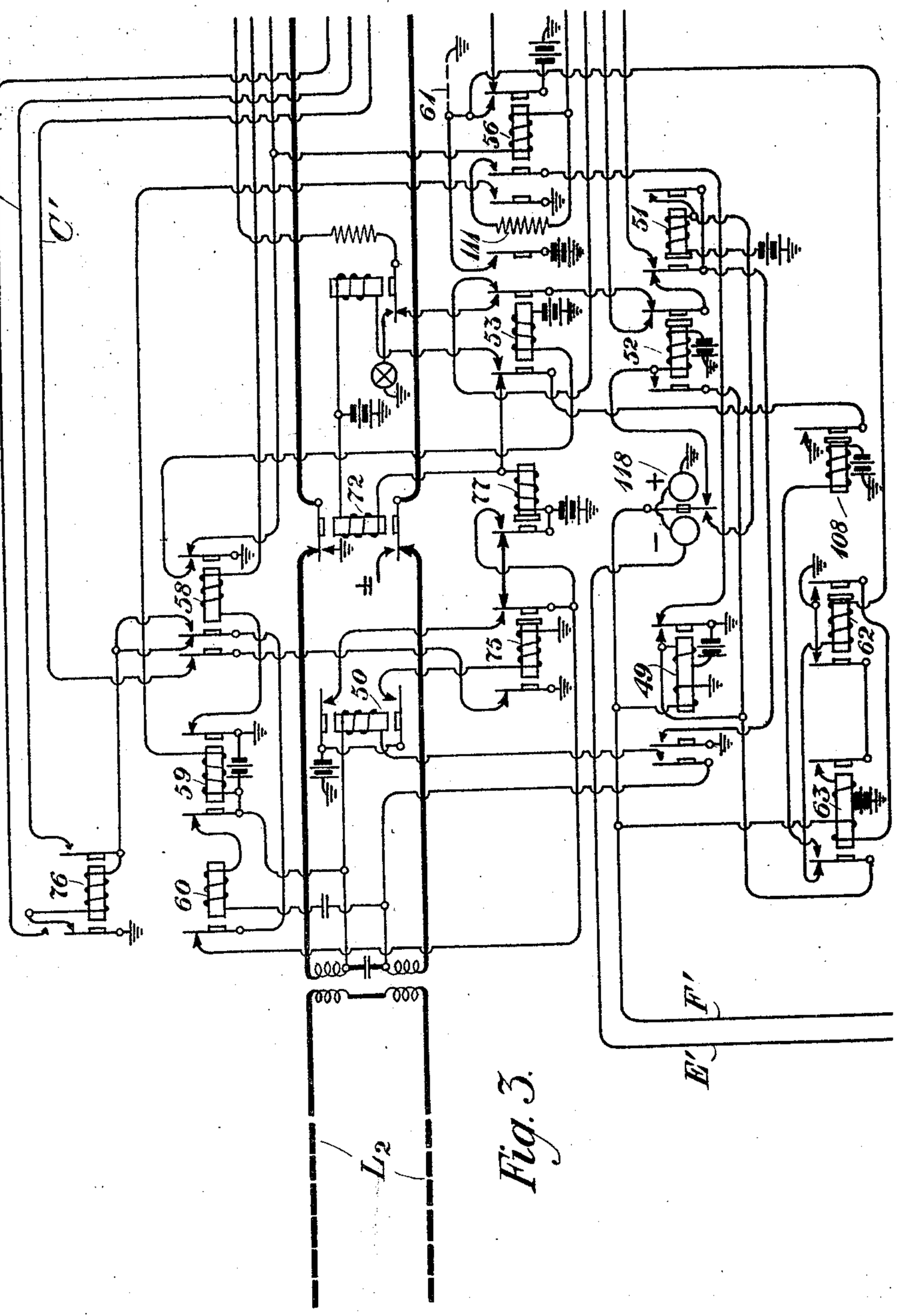

Fig. 3.

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8 SHEETS—SHEET 4.

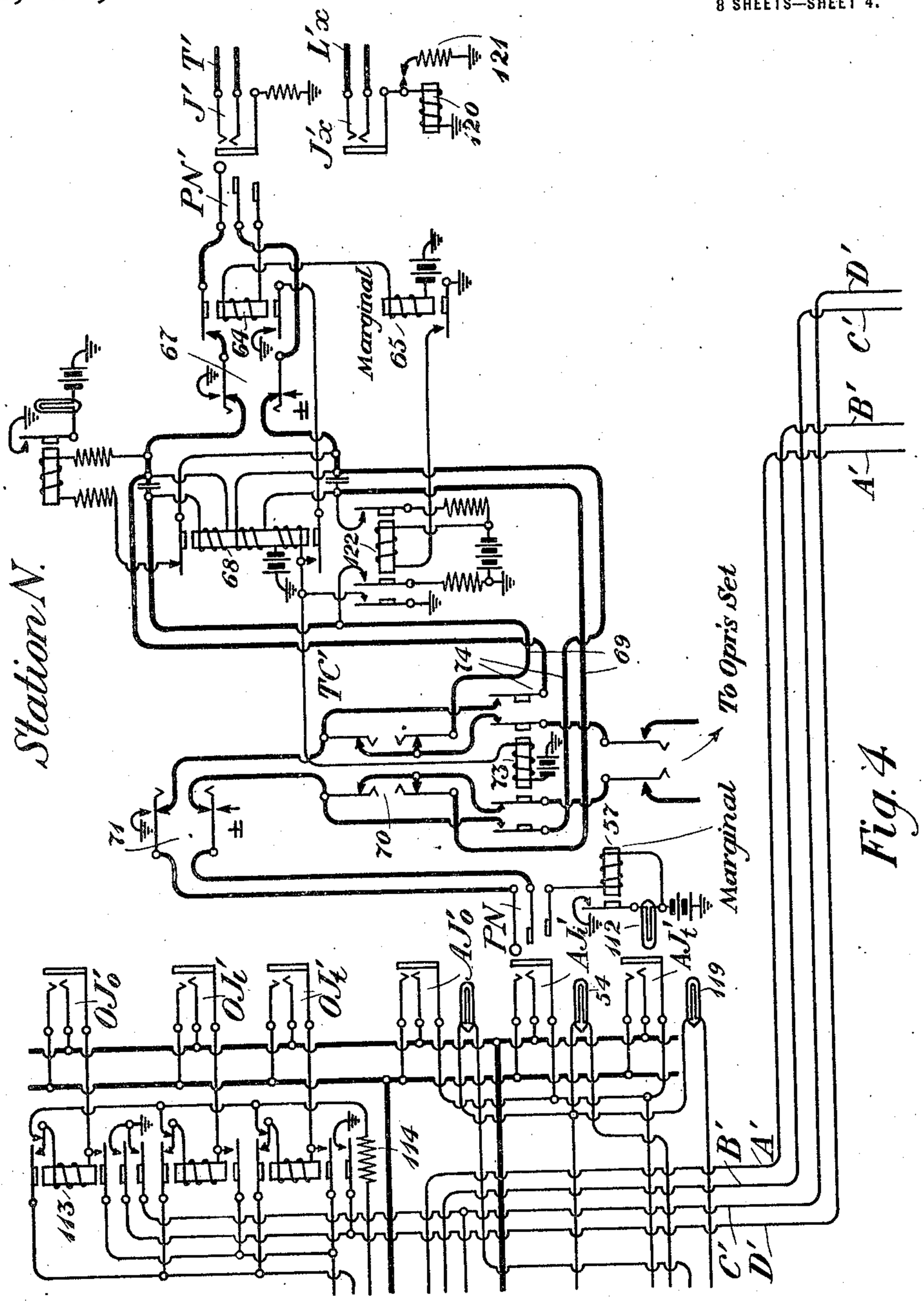

Fig. 4

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8 SHEETS—SHEET 5.

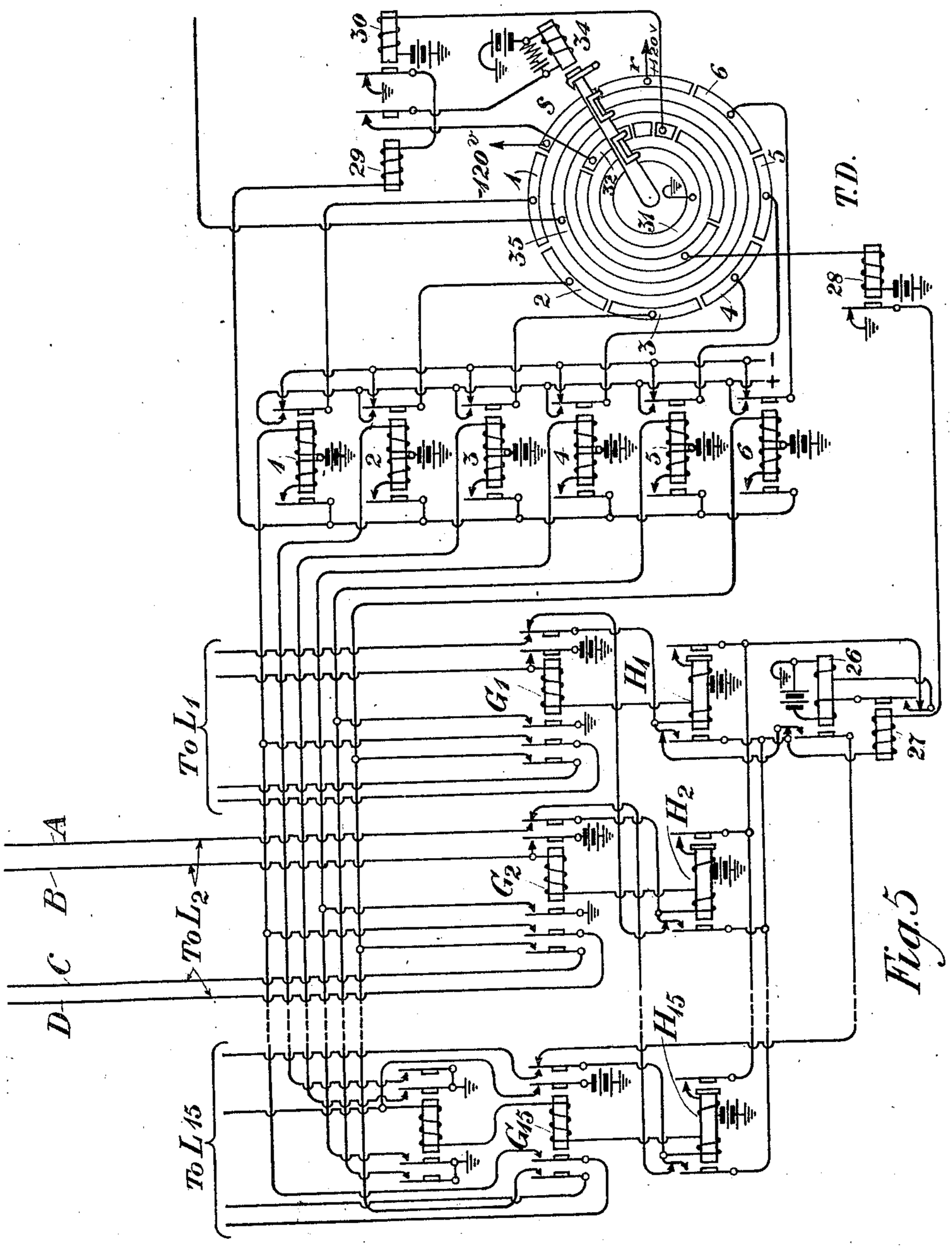

Fig. 5

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8 SHEETS—SHEET 6.

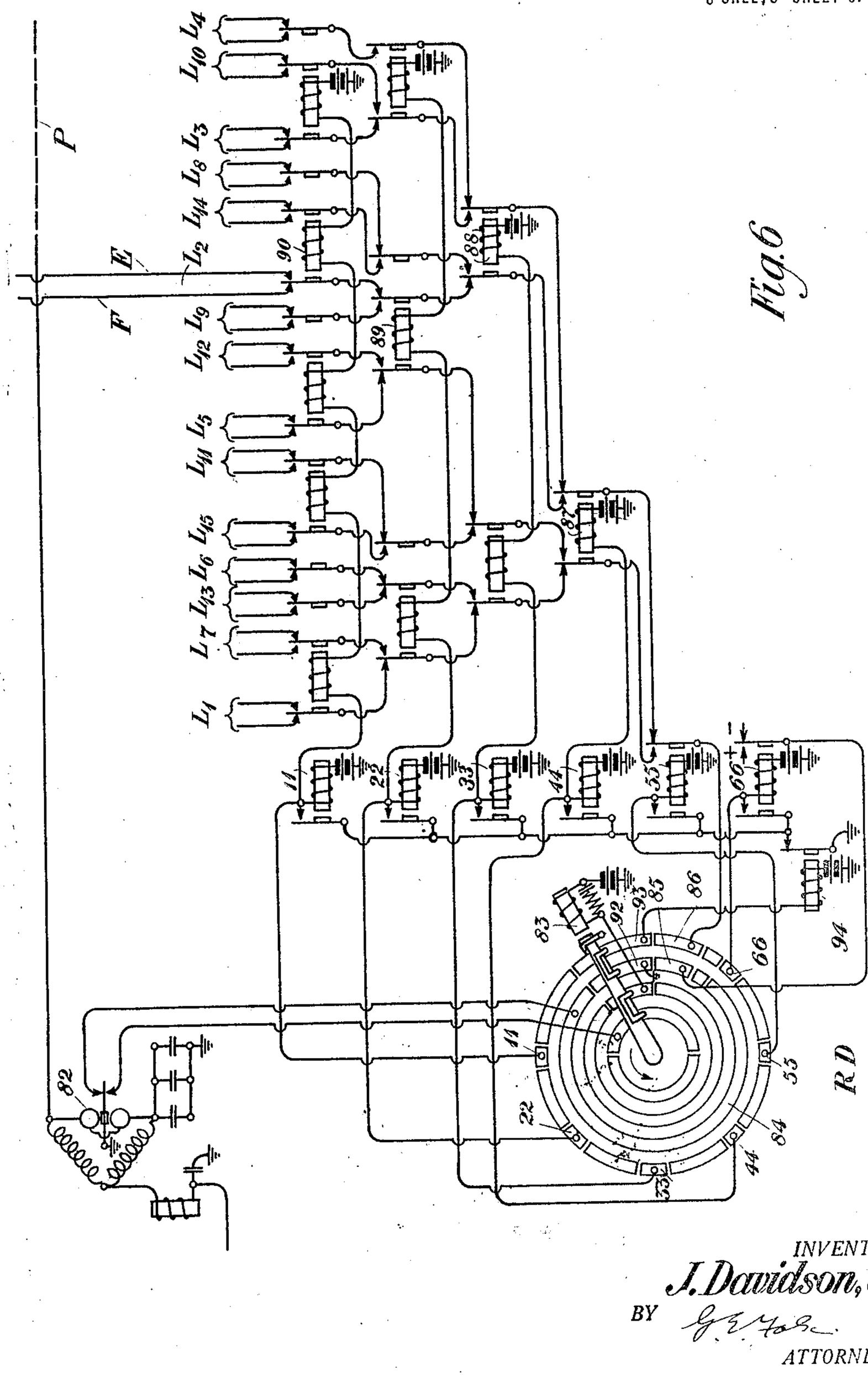

Fig. 6

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8 SHEETS—SHEET 7.

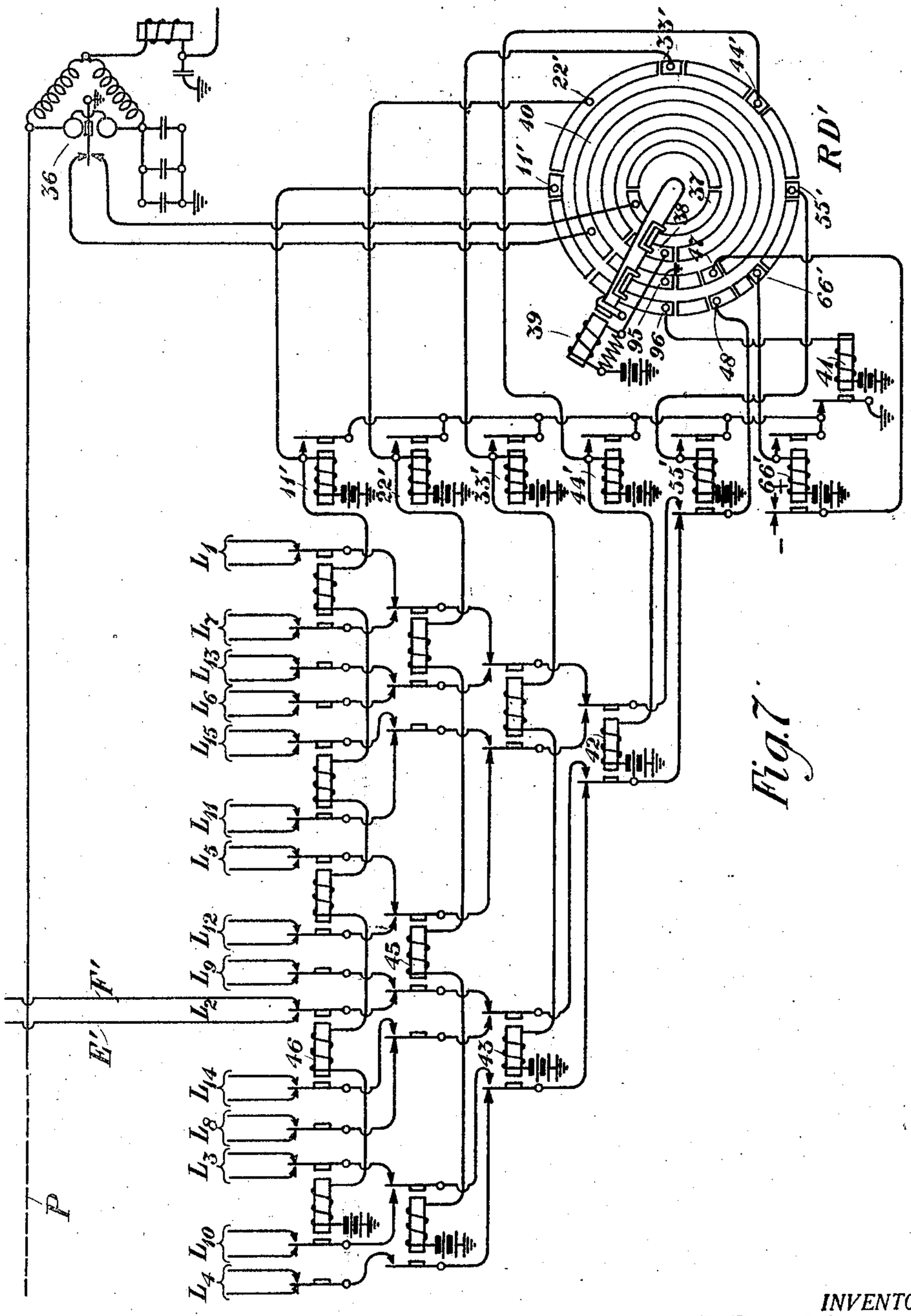

Fig. 7.

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8 SHEETS—SHEET 8.

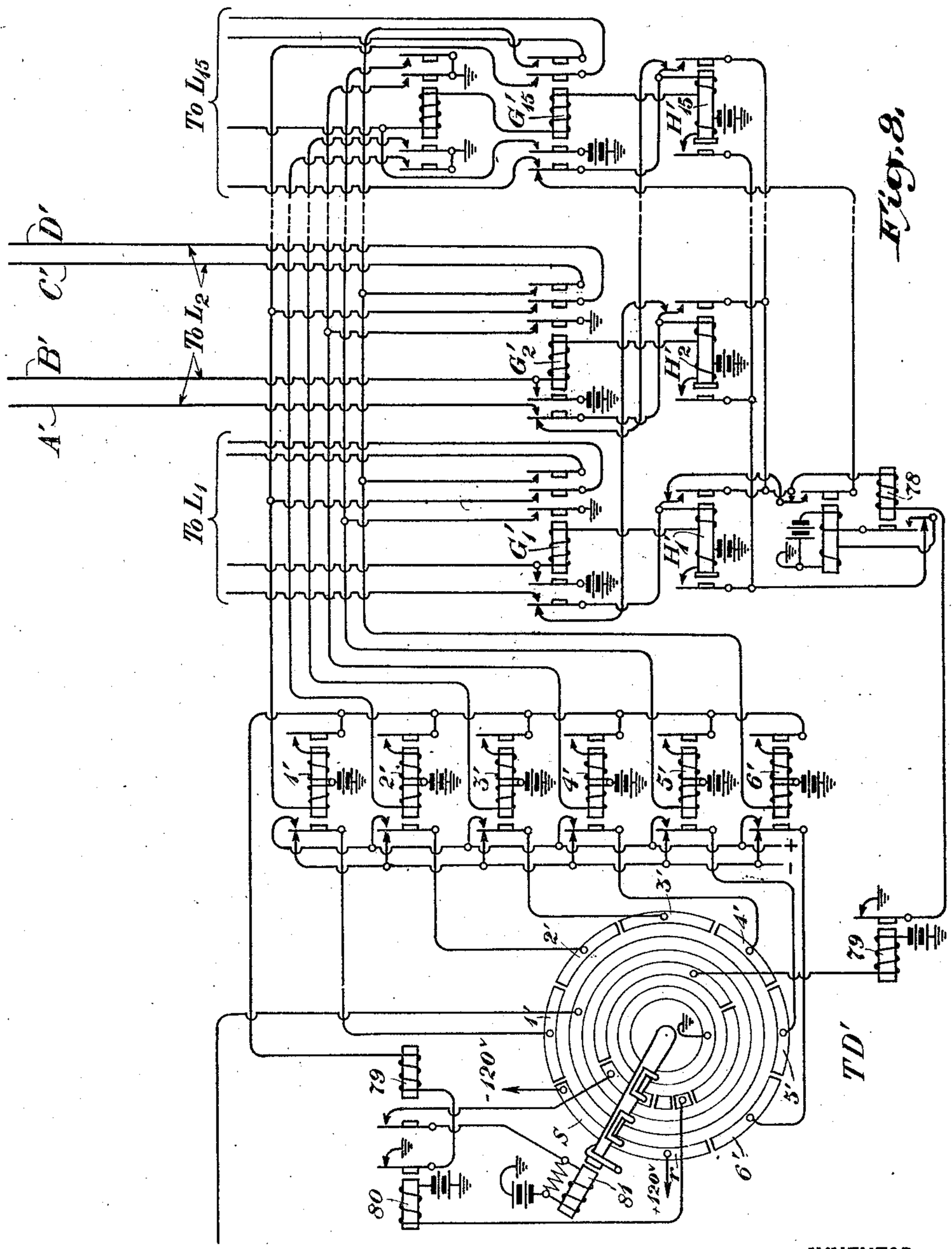

Fig. 8.

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Patented Sept. 26, 1922. 1,429,931

UNITED STATES PATENT OFFICE.

JOHN DAVIDSON, JR., OF MONTCLAIR, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SIGNALING CIRCUITS FOR TOLL LINES.

Application filed December 12, 1918. Serial No. 266,487.

To all whom it may concern:

Be it known that I, JOHN DAVIDSON, Jr., residing at Montclair, in the county of Essex and State of New Jersey, have invented certain Improvements in Signaling Circuits for Toll Lines, of which the following is a specification.

This invention relates to signaling circuits and more particularly to signaling circuits for use in connection with long distance telephone lines.

One of the objects of this invention is to provide a toll line terminating at an office at a plurality of positions and so arranged that an operator at a different office may signal anyone of the positions. Another object of the invention has reference to the provision of a two way toll line so designed that connections may be established thereover in either direction. A further object of the invention has reference to the provision of a toll line of such character that when a connection is established over two or more of such lines in tandem, the orginating operator has complete control over the connection, independent of any intervening operators who may have taken part in setting up the connection. A still further object of the invention is to provide signaling arrangements for toll lines, such that when a connection is established over two or more of such lines in tandem, signals originating at the distant end of one of the lines will be transferred by the connecting means of the lines to the distant end of the next line connected thereto. The invention also has for one of its objects, the provision of a link circuit for connecting two toll lines in tandem, the link circuit being so arranged that when the connection is once established the tandem operator will be automatically prevented from listening in or interrupting the connection by means of her controlling keys. Other and further objects of the invention will be clear from the detailed description hereinafter given.

The objects of this invention are secured, as herein disclosed, by providing a plurality of toll lines, each of which terminates at each end at a plurality of positions. At one of these positions, hereinafter called the "outgoing position", an outgoing toll operator may initiate calls which are to be extended over the line. At another of these positions, hereinafter called the "incoming position", an incoming toll operator may complete the local calls coming in over the long distance line. At another of these positions, hereinafter referred to as the "through position", a through toll operator may complete connections incoming from one toll line to another toll line, thereby extending the connection to a distant station.

In order that an originating operator may select any one of the positions at the distant end of the toll line, such an operator is provided with an outgoing jack corresponding to each of the positions at the distant station. By plugging into the proper jack, signaling equipment is set into operation, whereby a lamp is lighted at the particular position desired. In order that the signaling operations thus required may be performed economically, a signaling path is provided which is common to a plurality of toll lines and over which the various signals incidental to the establishment of connections over a plurality of lines may be successively transmitted. The arrangement for successively transmitting the signals over a common path may be of the general type disclosed in United States patents to Bancroft Gherardi, Numbers 1,251,363 and 1,251,364, granted December 25, 1917. As herein disclosed, however, the apparatus of the said Gherardi patents is modified so as to permit of transmitting one or more code combination for each of the toll lines, said combinations corresponding to different signals. The use of code combinations to transmit the different signals, readily permits of the selection of different positions at distant stations since each position may have a particular code combination assigned to it. The apparatus for translating the signals into code combinations and for translating the code combinations into signals at the distant station is herein illustrated as being of the same type as that disclosed and claimed in patent No. 1,413,708, issued April 25, 1922.

In order that the originating operator may have entire supervision over all connections, whether extended over a single toll line or over a plurality of toll lines in tandem, a toll cord is provided, of such character that when it is used for originating connections the operator may at any time come in upon the connection for any purpose whatsoever, but when used at an incoming or through position for completing

or extending connections originating at a distant station, the toll operator will be automatically disconnected from the toll line as soon as the connection has been completed and she will be unable thereafter to listen in or interfere with the connection except for the purpose of taking down the connection upon receiving a disconnect signal. Since the originating toll operator is to have entire supervision of the connection, some arrangement must be provided whereby the signals transmitted over a signaling path to the distant end of a toll line may be repeated or otherwise extended over the succeeding toll line connected in tandem therewith. This result is accomplished by providing the toll cord with signal responsive means adapted to be actuated by signals incoming from one toll line and arranged to control signal initiating apparatus whereby similar signals may be transmitted over the signaling path for the succeeding toll line.

The invention may now be more fully understood from the following description when read in connection with the accompanying drawings, Figures 1 to 8, inclusive, of which, when taken together, constitute a circuit diagram of a preferred embodiment of the invention. In order that the drawing may be more clearly read the sheets should be arranged with Figures 1, 2, 3 and 4 arranged end to end, and Figures 5, 6, 7 and 8 likewise placed end to end and below the first four figures.

Referring to the drawing, a toll line L_2 is shown extending between two distant stations M and N. At each station the toll line terminates in a number of jacks and associated signaling equipment, the apparatus at each station being identical. In order to establish connections between a local line and a long distance toll line, or between two long distance toll lines, toll cords, such as TC and TC′, may be provided at the terminating stations of the toll line. The toll cord TC at station M terminates in plugs PM and PM′. The plug PM is adapted to co-operate with any one of a plurality of jacks, OJ_o, OJ_i, OJ_t, AJ_o, AJ_i, AJ_t. By inserting the plug PM in the jack OJ_o, a connection will be extended over the toll line and a lamp associated with the answering jack AJ_o' at the outgoing board of the distant station will be lighted, thereby calling the attention of the outgoing operator. By inserting the plug PM in the jack OJ_i a lamp associated with the answering jack AJ_i' at the incoming board of the distant station will be lighted. Likewise, by inserting the plug PM in the outgoing jack OJ_t, a lamp associated with the answering jack AJ_t' at the through operator's station will be lighted. The plug PM may also be inserted in any of the answering jacks AJ_o, AJ_i or AJ_t, in answering incoming calls extended from the distant station by inserting the plug PN of the toll cord TC′ at that station into some one of the outgoing jacks OJ_o', OJ_i' or OJ_t'. The plug PM′ of the toll cord TC may be used in connection with a toll switching trunk, such as T, from a local line, or said plug may be inserted in the jack of a long distance line over which a connection is to be established in tandem with the line, such as L_2. In a similar manner, the plug PN′ of the cord TC′ at station N may be used for connections extended in the opposite direction.

In order that signals may be transmitted for selectively lighting the lamps at the incoming board and for performing the various other signaling operations incidental to the establishment of a connection, a signaling path P, extending between the two stations M and N, is provided, said signaling path being common to a plurality of toll lines, such as L_2, extending between said stations. Said signaling path terminates at the distant stations in bridged polar duplex sets of the type commonly used in duplex telegraph systems. Since the common signaling path is to be used for transmitting signals of a plurality of toll lines, some arrangement must be provided whereby the signals of a plurality of lines will be sent in succession and in predetermined order. For this purpose, a pair of relays G_2 and H_2 are associated with the line L_2 at station M, similar relays G_2', and H_2' being associated with the line at station N. All of the other lines signaling over the path P are provided with similar relays at the two stations. These relays perform the triple function of preventing the transmission of more than one signal at a time, of determining the order in which the signals of lines which are simultaneously in signaling condition shall be transmitted and of translating the signals into code combinations to be transmitted over the signaling path. The H relays associated with the lines are so arranged that they remain locked up after the signal of the corresponding line has been transmitted, thereby determining that signals of waiting lines shall be transmitted in numerical order beginning with the line whose H relay is nearest on one side of the H relay of the line last signaled. As soon as a new line obtains control of the circuit, the H relay of the previous line is unlocked and released.

In order to transmit the code combinations determined by the relay arrangements above described, an intermittently operating transmitting distributor TD is associated with the signaling path P at the station M for transmitting from station M to station N, and an intermittently operating receiving distributor RD′ is associated with the

signaling path P at the station N for receiving the transmitted code combinations. Similarly, transmitting distributor TD′ and receiving distributor RD are provided at stations N and M, respectively, for code combinations transmitted in the opposite direction. These distributors are similar to the so called start-stop distributors used in connection with printing telegraph systems. In order to translate the received code combinations into signals and to appropriate the signals to the proper toll line, pyramid relay combinations, illustrated in Figures 6 and 7, are provided at stations M and N, respectively. Various circuit controlling relays are also associated with the toll lines at the two stations for controlling the circuit changes resulting from the various signals.

In order that a signal originating with a given toll line, extending from one station to another, may, when arriving at the distant station be transmitted from that station to still another station, to which a toll line connected in tandem with the first mentioned toll line extends, the toll cords for connecting the toll lines in tandem are provided with marginal relays in their sleeve circuits. These marginal relays are responsive to received signals and control the connection of battery with the talking conductors of the toll cord, thereby originating similar signals which may be transmitted to the distant station of the tandem toll line.

Further details of the apparatus may be best understood from a description of the operation thereof which is as follows:

Assuming that it is desired to establish a long distance connection between a local calling line at station M and a local called line at station N, the plug PM′ of the toll cord TC at the station M will be inserted in the jack J of the toll switching trunk T associated with the calling line, and the plug PM will be inserted in the outgoing jack OJ_1 of the toll line L_2 for the purpose of extending the connection over said line and signaling the incoming operator at station N. A circuit is thereby completed from ground, over the sleeve contacts of jack J and plug PM′ and through the windings of relay 12 and marginal relay 13 to battery. Relay 12 is energized to close the talking conductors of the toll cord TC, but relay 13 is marginal and does not respond to current flowing over this circuit. A circuit is also completed from battery, through the winding of marginal relay 14, over the sleeve contacts of plug PM and jack OJ_1, through the winding of relay 15, upper back contact of said relay, through resistance 16 and over the back left hand contact of relay 17 to ground. Relay 14 is marginal and is not energized by current flowing over this circuit, but relay 15 is energized and completes at its upper front contact, a locking circuit over the sleeve circuit previously traced through the winding of said relay 15, upper front contact of said relay, through the winding of relay 17, over the back left hand contact of relay 18 to ground. Relay 17 is thereby energized and at its front left hand contact completes a circuit from ground through the winding of relay 19 to battery. Relay 19 upon being energized completes a circuit from battery, over its left hand front contact and over the dotted line conductor 20, through the various busy signals (not shown) associated with the toll line to ground. The other circuit changes incident to the energization of relay 19 are without effect at this time. Relay 17 by shifting its middle armature from its back to its front contact momentarily opens the locking circuit of relay 21, said circuit being traced as follows: from ground, right hand front contact and winding of relay 21, middle back contact of relay 17, back contact of relay 23, left hand back contact of relay 24 and right hand back contact of relay 25 to battery. Upon de-energization of relay 21 a circuit is closed over the left hand back contact of said relay as follows: from battery, over the back contact of relay 25, left hand back contact of relay 24, back contact of relay 23, front contact of relay 17, left hand back contact of relay 21, over conductor B and through the winding of relay G_2 and the left hand winding of relay H_2, from which point the circuit may be completed in several different ways depending on the conditions then existing. Assuming the circuits to be in the condition they would present in case no line had previously transmitted a signal, the circuit would be completed from the winding of relay H_2, over its left hand back contact, over the extreme right hand back contact of relay G_1, over the left hand back contact of relay H_1 over the back contact of relay 26, through the winding of relay 27 and over the back contact of relay 28 to ground. Under normal conditions, however, some one of the H relays would be locked up in series with the right hand winding of relay 26, over the back contact of relay 27, due to the fact that a signal had been transmitted by the line with which that particular H relay was associated. Assuming that the relay H_1 had thus been locked up the circuit of the relays G_2 and H_2 would extend from the winding of relay H_2 over the left hand back contact of relay H_2, extreme right hand back contact of relay G_1, left hand front contact of relay H_1, through the winding of relay 27 and over the back contact of relay 28 to battery. Relays 27, H_2, and G_2 will, therefore, be energized over some one of their possible circuits, providing that no G relay is at that time energized due to some other line being engaged in transmitting a signal. Relay 27 upon being energized completes a circuit over its front con-

tact, through the two windings of relay 26 in series, maintaining said relay energized. The energization of relay 27, at the same time, by opening its back contact breaks the locking circuit for the left hand winding of any H relay, such as H_1, which had been previously locked up. Relays G_2 and H_2 are now locked up over a circuit from battery, over the inner right hand front contact of relay G_2, through the winding of said relay and through the left hand winding of relay H_2 and thence over the circuit previously traced to ground, at the back contact of relay 28. Upon the energization of relays G_2 and H_2 a circuit is also completed as follows: from ground, back contact of relay 28, through the winding of relay 27, over the front left hand contact of relay H_2, front extreme right hand contact of relay G_2, over the conductor A, over the back right hand contact of relay 21, through winding of said relay. over the front middle contact of relay 17 and thence over the circuit previously traced to battery, at the back contact of relay 25. Relay 21 is again energized and locked up by the circuit thus completed.

Before proceeding with the translating operations resulting from the energization of relay G_2, the manner in which the order of transmission of signals from different lines is determined will be described. Assuming that while line L_2 has control of the circuit signals should be initiated by lines L_1 and L_{15}, the G and H relays of said lines cannot be operated for the reason that the ground connections from the left hand windings of the H relays of said lines extend over the extreme right hand contact of relay G_2, which contact is now opened. When the signal initiated by line L_2 has been transmitted, the relay 28 will be energized, as hereinafter described, thereby de-energizing relay G_2 and 27. The de-energization of relay 27 closes a locking circuit from the right hand winding of the relay H_2, over the front right hand contact thereof, over the back contact of relay 27 and through the right hand winding of relay 26 to ground, thereby maintaining relays H_2 and 26 energized. Relays G_{15} and H_{15} of line L_{15} will now be energized in preference to relays G_1 and H_1 for the reason that the ground connection for relays H_1 and G_1 must pass over the extreme right hand contact of relay G_{15} which upon energizing will hold open the circuit for relays G_1 and H_1. The circuit for relays G_{15} and H_{15} will be completed through the winding of relay G_{15}, left hand winding of relay H_{15}, extreme right hand back contact of relay G_2, left hand front contact of relay H_2, through the winding of relay 27, over the back contact of relay 28 to ground. Relay 27 is now energized and completes a circuit for the relay 26, through its two windings in series, at the same time opening the locking circuit through the right hand winding of relay H_2, which is accordingly de-energized. The energization circuit for relays G_1 and H_1 would have to extend from the left hand winding of relay H_1, over the left hand back contact of said relay, front contact of relay 26 and over the right hand contact of relay G_{15}, over the front left hand contact of relay H_{15} to the winding of relay 27, over the back contact of relay 28 to ground. It will be seen, therefore, that line L_{15} has the preference. Assuming now that while line L_{15} is signaling, a new signal has been originated on line L_2 in addition to the signal waiting on line L_1, as soon as the signal for line L_{15} is transmitted relay 28 opens a circuit of relay 27 and relay G_{15} and the relay H_{15} remains locked up through its right hand winding in series with the right hand winding of relay 26. Line L_1 now has preference over line L_2 since the circuit of its relays G_1 and H_1, as previously traced, will not be held open at any contact, whereas the circuit for relays G_2 and H_2 must pass over the right hand contact of relay G_1 which will be held open as soon as relay G_1 is energized. The circuit for relays G_2 and H_2 will be as follows: from battery, through the left hand winding of relay H_2 over the left hand back contact of said relay, over the extreme right hand contact of relay G_1, which will now be opened, over the front left hand contact of relay H_1, which is now energized, and thence through the winding of relay 27 and over the circuit previously traced to ground. Assuming now that while the signal originated by line L_1 is being transmitted, a signal is originated on line L_{15} in addition to that waiting upon the line L_2, upon the completion of the transmission of the signal of the line L_1, relay 28 is energized and opens a circuit of relays 27 and G_1, thereby locking the relay H_1, through its right hand winding. The line L_2 now has preference over the line L_{15} since the circuit just traced for relays G_2 and H_2 will be completed while the circuit for the relays G_{15} and H_{15} of the line L_{15} will be held open at the right hand contact of relay G_2. It will thus be seen that the G and H relays of the various lines are arranged in an endless chain, with the H relay of the line which transmitted the last signal always locked up so that a plurality of signals simultaneously waiting upon other lines will be transmitted in regular order beginning with the nearest line on the left of the G and H relays which transmitted the last signal.

Returning now to the translating operations incident to the energization of the relay G_2 resulting from the insertion of the plug PM in the jack OJ_1, it will be observed that at its inner left hand contact said relay con-

nects ground through the right hand winding of relay 4, thereby energizing said relay. Relay G_2 over its remaining left hand contacts controls circuits for relays 1 and 6, but since these circuits extend over conductors C and D, which are opened at this time, circuits for relays 1 and 6 are not closed. As soon as relay 4 is energized it completes a locking circuit through its left hand winding and over its left hand contact, through the winding of relay 29, and over the back contact of relay 30 to ground. Relay 29 is now energized and completes a circuit from ground, over the inner ring 31, through segment 32 of the transmitting distributor TD, over the front contact of relay 29 and through the windings of start magnet 34 to battery. The brusharm of the distributor is now released and in passing from the segment *r* to the segment *s* transmits a negative impulse over the signaling path P from the segment *s*, brush and ring 35 of the distributor, over the path P and through the winding of the polarized relay 36 at station N to ground. Previous to the transmission of this negative impulse positive current was flowing over the path P from the segment *r* of the distributor TD thereby holding the armature of the polarized relay 36 upon its upper contact. Upon receiving the negative starting impulse, however, the lower contact of the polarized relay is closed and a circuit is completed from ground, over said contact, over segment 37, brush and segment 38 of the receiving distributor RD′ at station N and through the winding of the start magnet 39 of said distributor to battery. The brusharm of the receiving distributor is now released and rotates in a clockwise direction.

It will be noted that as the brusharm of the transmitting distributor TD rotates over the segments 1 to 6, impulses are transmitted over the path P, whose polarity depends upon the conditions of relays 1 to 6. It will be remembered that relay 4 was energized so that the transmitting distributor now transmits a code combination consisting of three negative impulses, one positive impulse and two additional negative impulses. These impulses are received at the station N as the brusharm of the receiving distributor RD′ is passing over the segments 11′, 22′, 33′, and so forth. During the negative impulses the armature of the polarized relay is resting upon its lower contact and no circuit changes result from these impulses. When the fourth or positive impulse of the code combination is received, the brush of the distributor is passing over segment 44′ and a circuit is completed from ground, over the upper contact of polarized relay 36, segment 40 of receiving distributor RD′, brush and segment 44′ of said distributor and through the windings of relay 44′ to battery. Relay 44′ is locked up over its front contact and over the back contact of relay 41. Relay 44′ also closes a circuit from battery, through the winding of pyramid relay 42, over the front contact of relay 44 and over the back contact of relay 41 to ground. Just after receiving the last impulse of the code combination, the brusharm of the distributor passes over segments 47 and 48, thereby completing a circuit from negative battery, over the left hand back contact of relay 66′, over segments 47 and 48, left hand back contact of relay 55′, left hand front contact of relay 42, right hand back contact of relay 43, middle back contact of relay 45, right hand back contact of relay 46, over the conductor F′ and through the left hand winding of relay 49 to ground. Before coming to rest the brusharm of the distributor RD′ closes a circuit from ground, over segments 95 and 96 and through the winding of relay 41 to battery. Relay 41 is thereby energized and by opening its back contact breaks the locking circuit of relay 44′, thereby restoring the pyramid relays to normal.

Relay 49 is energized over the circuit above traced and at its right hand front contact completes a locking circuit through its right hand winding. At its extreme left hand contact a circuit is prepared for relay 50 and at its inner left hand front contact a circuit is completed from ground, over said contact, over the left hand back contact of relay 51, right hand back contact of relay 52, inner right hand back contact of relay 53, through lamp 54 associated with the answering jack AJ_i' at the incoming operator's position and over the right hand back contact of relay 56 to battery. The lamp 54 is now caused to glow thereby apprising the toll operator at station N that a calling line has been connected to the toll line L_2. The operator thereupon inserts the plug PN of the toll cord TC′ into the jack AJ_i' thereby completing a circuit from battery, through the winding of marginal relay 57, sleeve contacts of the plug and jack, through the winding of relay 56 and over the back contact of relay 58 to ground. Relay 56 is energized over the circuit thus traced, but relay 57 is marginal and does not pull up its armature. The energization of relay 56 at its extreme left hand front contact closes a circuit from ground, over said contact and through the windings of relay 59 to battery. Relay 59 is energized to hold open the circuit of the ringing responsive relay 60 and also to hold open a circuit of the relay 58 so that it cannot be energized by the operator inadvertently inserting a plug in one of the outgoing jacks associated with the toll line L_2 at the station N. Relay 56 at its right hand contact opens a circuit previously traced for the lamp 54, extinguishing said lamp and at its front right hand contact completes a circuit

from battery, over the dotted conductor 61 and through busy signals (not shown) associated with the toll line L^2 at various terminal positions and thence to ground. A circuit is also completed over the front right hand contact of relay 56, from battery, through the winding of relay 62, over the left hand contact of relay 63 and over the right hand front contact of relay 49 to ground. Relay 62 is now energized but produces no effective results at this time.

The toll operator at station N also inserts the plug PN′ of the toll cord TC′ into the jack J′ of the toll switching trunk T′, over which the connection is extended by the B operator to the called subscriber's line. This operation results in the energization of sleeve relay 64 but sleeve relay 65 is marginal and is not actuated. The energization of relay 64 closes the tal' ng conductors of the toll cord. As soon a; the connection is completed to the called subscriber's line over the toll switching trunk T′, the called subscriber's receiver being on the switch hook, battery is bridged across the talking conductors of the toll switching trunk in a manner well known in the art, thereby completing a circuit over the tip and ring conductors of the jack J′ and the plug PN′, over the contact of relay 64 and the normal contacts of the ringing key 67, through the upper and middle windings of the triple wound relay 68, over the conductors 69 of the toll cord, over the contacts of the splitting key 70 and ringing key 71, tip and ring contacts of the plug PN and jack AJ_1', over the normal contacts of the ringing relay 72 and over the left hand front contact of relay 49 to the winding of relay 50. Relay 50 and the triple wound relay 68 are energized over the circuit thus traced and relay 68 is locked up from battery, through its lower winding and over its lower front contact and over the lower front contact of relay 64 to ground. A circuit is also completed from ground over the lower front contact of relay 64, over the lower front contact of relay 68 and through the winding of relay 73 to battery. Relay 73 upon being energized automatically disconnects the operator's set from the toll cord and at its outer front contacts completes a talking connection over conductors 74 of the toll cord, thereby short circuiting the upper windings of relay 68 and the condensers and contacts of the splitting key 70. The toll operator now has no further control over the connection except to take it down in response to a disconnect signal. The above circuit changes also eliminate transmission losses due to the contacts of the splitting key, the windings of the relay 68 and the condensers.

The energization of the relay 50, upon the completion of the connection to the called subscriber's line, closes a circuit from battery over the lower front contact of said relay and through the winding of slow release relay 75 to ground. Relay 75 in shifting its right hand armature from its back to its front contact momentarily opens the circuit of locking relay 76, which might have been traced from battery, over the back contact of relay 77, right hand back contact of relay 75, back contact of relay 60, middle back contact of relay 58 and through the winding and over the front left hand contact of relay 76 to ground. Relay 76 is now de-energized and a circuit is thereby completed from battery over the upper front contact of relay 50, right hand front contact of relay 75, back contact of relay 60, middle back contact of relay 58, right hand back contact of relay 76, over the conductor B′, and assuming that no signal is being transmitted from any other line, through the winding of relay G_2' and the right hand winding of relay H_2', over a path, depending upon the condition of the lock-out circuit at this time, through the winding of relay 78 and over the back contact of relay 79 to ground. The lock-out function of G′ and H′ relays at station N is exactly the same as that at station M and need not be further described. Relay G_2' upon being energized completes a locking circuit from battery, over its inner left hand front contact, thereby locking up said relay and the relay H_2'. At its extreme left hand front contact relay G_2' closes a circuit from ground, over the back contact of relay 79, winding of relay 78, right hand contact of relay H_2', left hand contact of relay G_2', over conductor A′, left hand back contact and winding of relay 76, middle back contact of relay 58 and thence over a circuit previously traced to battery at the upper front contact of relay 50. Relay 76 is again energized and locked up. At its inner right hand contact relay G_2' connects ground through the left hand winding of relay 4′ to battery, thereby energizing said relay. The remaining right hand contacts of relay G_2 control circuits of relay 1′ and 6′. These circuits are opened at this time and hence these relays are unenergized.

As soon as the relay 4′ is energized a locking circuit is completed through its right hand winding and over its right hand front contact, through the winding of relay 79 and over the back contact of relay 80 to ground. Relay 79 closes a circuit of the start magnet 81 of the transmitting distributor TD′, thereby releasing the brush-arm of the distributor, which now transmits over the signaling path P a negative starting impulse followed by a code combination consisting of three negative impulses, one positive impulse and two additional negative impulses, the positive impulse being due to the energization of relay 4′. The starting impulse transmitted over the path P, acting upon the polarized relay 82 at station M, re-

sults in the energization of the start magnet 83 of the receiving distributor RD at station M. The brusharm of the distributor upon being released rotates in a counter clockwise direction over the various segments and in response to the positive impulse transmitted over the path P completes a circuit from battery through the winding of relay 44, over the segments 44 and 84 of the distributor and over the upper contact of polarized relay 82 to ground. An instant after the code combination has been received, the brusharm, in passing over segments 85 and 86 of the distributor, completes a circuit from negative battery, over the right hand back contact of relay 66, segments 85 and 86, right hand back contact of relay 55, front right hand contact of pyramid relay 87, which was energized by relay 44, back left hand contact of relay 88, middle back contact of pyramid relay 89, left hand back contact of pyramid relay 90, over conductor F and through the right hand winding of relay 91 to ground. The brusharm of the distributor just before coming to rest completes a circuit from ground, over segments 92 and 93, through the winding of relay 94, which by opening its right hand back contact breaks the locking circuit of relay 44 and restores the pyramid relay circuit to normal.

The energization of relay 91, over the circuit traced through its right hand winding, results in preparing a circuit for the relay 97, over the extreme right hand front contact of relay 91. Relay 97 and the triple wound relay 98 of the toll cord TC are not energized, however, as battery is disconnected from the toll switching trunk T due to the fact that the calling subscriber has his receiver removed from the switch hook. Relay 91 at its left hand front contact completes a locking circuit through its left hand winding and also completes a circuit from ground over said contact, over the back right hand contact of relay 99, through the winding of slow release relay 100 and over the front left hand contact of relay 19 to battery, thus energizing relay 100. At its inner right hand front contact relay 91 completes a circuit from ground, over the right hand back contact of relay 101, left hand back contact of relay 102, middle front contact of relay 19, back contact of relay 103, through resistance 104, lower front contact of relay 15 and over the sleeve conductors of plug PM and jack OJ_1 and through the winding of marginal relay 14 to battery. The completion of the circuit above traced in shunt with the winding of the relay 15 decreases the resistance of the sleeve circuit sufficiently to operate the marginal relay 14, which is now energized to complete the circuit of the lamp 105.

The glowing of lamp 105 indicates to the toll operator at station M that the connection has been completed to the called subscriber and his line is now ready to be rung. The toll operator therefore actuates the ringing key 106 of the toll cord TC and applies ringing current over the tip and ring conductors of the line L_2, through the left hand windings of the transformer 107 and over the back right hand contact of relay 18 to the winding of ringing responsive relay 23. Relay 23 by opening its right hand contact breaks the locking circuit of relay 21, which (it will be remembered) passed over said contact. As soon as the ringing current ceases and the relay 23 is again deenergized, a circuit will be completed from battery, over the back contact of relay 25, left hand back contact of relay 24, back contact of relay 23, middle front contact of relay 17, back contact of relay 21 and over the conductor B and through the winding of relay G_2 and the left hand winding of relay H_2 to ground at the back contact of relay 28. Relay G_2 upon being energized again locks up the relay 21 over the conductor A and at its inner left hand contact closes a circuit for the relay 4, thereby setting the transmitter TD into operation to transmit over the path P a starting impulse followed by the same code combination as was transmitted before; viz., three negative impulses, a positive and two additional negative impulses. The receiving distributor RD′ at station N is therefore released and in response to this code combination again transmits a negative impulse from negative battery, over the back left hand contact of relay 66′, segments 47 and 48 of the distributor, left hand contact of relay 55′, left hand front contact of relay 42, right hand back contact of relay 43, middle back contact of relay 45, right hand back contact of relay 46, over the conductor F′ and through the left hand winding of relay 49 in parallel with a circuit through the left hand winding of relay 63 and over the right hand front contact of relay 62 to ground. Relay 49 being already locked up, no effect was produced by this impulse upon said relay. Relay 63 is energized and completes a circuit from battery through the left hand front contact of relay 62 to ground. At its left hand front contact relay 63 completes a circuit from ground, over the right hand front contact of relay 49, left hand front contact of relay 63 and through the winding of slow release relay 108 to battery. Relay 108 completes a circuit from ground over its front contact, over the back left hand contact of relay 53 and thence in parallel through the windings of relays 72 and 77 to battery. Relay 72 is maintained energized for a brief period during which the slow release relay 62 is deenergized by the opening of its circuit at the left hand contact of relay 63, thereby unlocking relay 63 which releases and in

turn causes the de-energization of relay 108. These relays are sufficiently slow acting, however, to maintain the relay 72 energized for a period sufficiently long to perform the ringing operation. The actuation of relay 72 in applying ringing current over the toll cord TC′ and the toll switching trunk T′ to the called subscriber's line opens the circuit of the relay 50 which in turn causes the de-energization of relay 75. In order to prevent the opening of the locking circuit of the relay 76, due to this operation, the actuation of relay 77 completes an additional locking circuit for said relay 76, from battery, over the front contact of relay 77, over the back contact of relay 60, middle back contact of relay 58 through the winding of relay 76 and its left hand front contact to ground.

When the called subscriber responds to the ringing signal thus transmitted, battery is disconnected from the talking conductors of the toll switching trunk T′, in a manner well known in the art, thereby causing the de-energization of the relay 50, which, assuming that the relay 77 has been de-energized at the completion of the ringing operation, opens at the upper contact of said relay 50 a locking circuit of the relay 76, which is de-energized, thereby completing a circuit from battery, over the back contact of relay 77, back right hand contact of relay 75, back contact of relay 60, middle back contact of relay 58, back contact of relay 76, over the conductor B′, through the winding of relay G_2' and the right hand winding of relay H_2' to ground at the back contact of relay 79. Relay G_2' upon being energized completes a circuit over the conductor A′ to again lock up the relay 76 and at its inner right hand front contact connects ground through the left hand winding of relay 4′ to energize said relay. At its outer right hand front contact relay G_2' completes a circuit for the relay 6′ as follows: from ground over the left hand back contact of relay 75, extreme left hand back contact of relay 58, conductor C′, outer right hand contact of relay G_2' and through the left hand winding of relay 6′ to battery. Relays 4′ and 6′ are now locked up and release the brusharm of the distributor TD′ to transmit a starting impulse followed by a code combination consisting of three negative impulses, a positive impulse, another negative and a final positive impulse.

At station M the receiving distributor RD is set into operation by the starting impulse and in response to the code combination relays 44 and 66 are energized and locked up so that a momentary circuit is closed from positive battery, over the front right hand contact of relay 66, segments 85 and 86, back right hand contact of relay 55, front right hand contact of relay 87, back left hand contact of relay 88, back middle contact of relay 89, back left hand contact of relay 90 and over the conductor F, through the right hand winding of relay 91. The impulse thus caused to flow through the right hand winding of relay 91 is of such a direction as to cause a differential action between the two windings of said relay so that said relay is de-energized, thereby opening at its left hand contact a circuit previously traced for relay 100, which is now de-energized. At its inner right hand contact relay 91, upon being de-energized opens the shunt circuit previously traced. through resistance 104, about the winding of relay 15, so that marginal relay 14 no longer receives sufficient current to energize its winding and the lamp 105 is extinguished to indicate to the toll operator at station M that the called subscriber has answered.

Should the called subscriber desire to attract the attention of the toll operator at station M by flashing his switch hook, the relay 50 of the toll line L_2 will be intermittently energized and de-energized in response to the flashing of the switch hook, which intermittently connects battery to the talking conductors of the toll switching trunk T′. Relay 50 at its lower front contact sends a succession of impulses through the winding of slow release relay 75 which is maintained energized during the flashing of the switch hook. Relay 50 in moving its upper armature from its front contact while relay 75 is energized, momentarily opens the circuit of locking relay 76, which is thereby de-energized, and a circuit is completed from battery, over the upper front contact of relay 50, right hand front contact of relay 75, back contact of relay 60, middle back contact of relay 58, back contact of relay 76, over the conductor B′ and through the winding of relay G_2' and right hand winding of relay H_2' to ground at the back contact of relay 79. Relay G_2' upon being energized is locked up and at its front left hand contact completes a circuit over conductor A′ to again energize and lock up the relay 76. The circuit for the relay 76, however, it will be noted, passes over the upper front contact of relay 50, which is intermittently closed in response to the flashing of the switch hook. Consequently, the relay 76 will continue to be intermittently de-energized to transmit a succession of recall signals as often as it is able to obtain control of the lock-out circuit between periods when other lines are transmitting signals. The energization of the relay G_2' at its inner right hand front contact completes a circuit for the relay 4′. The circuit over conductor C′ controlled by the outer right hand contact of relay G_2' is held open at the left

hand contact of relay 75 and a circuit for conductor D′ is also opened. Consequently, relays 1′ and 6′ are not actuated. Relay 4′ upon being energized and locked up releases the transmitting distributor TD′ to transmit a starting impulse followed by a code combination of three negative impulses, one positive and two additional negative impulses each time the line L_2 obtains control of the distributor TD during the flashing operation

At station M distributor RD is released by the starting impulse and in response to the fourth, or positive impulse, causes the relay 44 to be energized and locked up, thereby completing a circuit for the relay 87. A negative impulse is now transmitted from negative battery, over the back right hand contact of relay 66, over segments 85 and 86, right hand back contact of relay 55, front right hand contact of relay 87, back left hand contact of relay 88, middle back contact of relay 89, left-hand back contact of relay 90, over conductor F and through the right hand winding of relay 91 to ground. Relay 91 is again locked up as before and completes a circuit through its left hand front contact to energize the relay 100. At its inner right hand contact relay 91 again closes the shunt circuit through resistance 104, about the winding of relay 15, to cause the marginal relay 14 to be energized, thereby completing a circuit for the lamp 105.

As previously stated, however, due to the intermittent closing of the upper contact of relay 50, the same signal is successively repeated by the relay G_2' and H_2' and the same code combination will again be transmitted over the signaling path P. When the receiving distributor, in response to the retransmission of this code combination, sends a second negative impulse over the conductor F, said impulse, in addition to flowing through the right hand windings of relay 91, also flows through the right hand winding of relay 99 and over the left hand front contact of relay 100 to ground. Relay 99 is locked up and at its left hand front contact completes a circuit from ground, over the left hand front contact of relay 91, over the right hand front contact of relay 99, through the winding of relay 109 to battery. At the same time that this circuit is closed through the relay 99, the circuit previously traced through the relay 100 is opened and after an interval this relay is de-energized thereby opening a circuit of relay 109 which, after an additional interval, will also be de-energized. The total time for this operation is considerable, however, and during this period a circuit is completed over the front contact of relay 109, front right hand contact of relay 19, through the winding of relay 103 to battery. Relay 103 upon being thus energized completes a circuit from ground through interrupter 110, front contact of relay 103, through resistance 104 to the sleeve contacts of plug PM and jack OJ_1, thereby intermittently shunting the winding of relay 15 to intermittently energize relay 14. This causes the lamp 105 to flash. The operations just described will continue at intervals so long as the called subscriber continues to flash his switch hook, thereby indicating to the toll operator at station M that the called subscriber desires her attention.

Upon receiving a disconnect signal from the calling subscriber at the completion of the conversation, the toll operator at station M will withdraw the plugs PM and PM′ from the corresponding jacks. This results in the de-energization of relay 15, which, (it will be remembered) was locked up in series with the relay 17. Relay 17, therefore, is also de-energized and in transferring its middle armature from its front to back contact, said relay momentarily opens the circuit of locking relay 21 which is thereby de-energized. A circuit is now closed from battery over the back contact of relay 25, left hand back contact of relay 24, right hand back contact of relay 23, middle back contact of relay 17, left hand back contact of relay 21, over the conductor B, through the winding of relay G_2 and left hand winding of relay H_2 to ground, at the back contact of relay 28. Relay G_2 at its outer right hand contact again locks up the relay 21, over the conductor A. At its inner left hand contact relay G_2 completes a circuit for the relay 4, which is energized and locked up; while at its outer left hand contact relay G_2 completes a circuit from ground, over the back right hand contact of relay 24, the outer right hand back contact of relay 17, over the conductor C, the outermost left hand contact of relay G_2, through the right hand winding of relay 6 to battery. Relay 6 is also energized and locked up. As soon as relays 4 and 6 are energized and locked up, the transmitting distributor TD is set into operation to transmit a starting impulse followed by a code combination, consisting of three negative impulses, a positive, another negative and a final positive impulse.

At station N the receiving distributor RD′ is now set into operation and in response to the code combination just transmitted, locks up relays 44′ and 66′. A momentary circuit is consequently completed from positive battery, over the front left hand contact of relay 66′, segment 47 and 48, back left hand contact of relay 55′, front left hand contact of relay 42, back right hand contact of relay 43, middle back contact of relay 45, right hand back contact of relay 46, over the conductor F′, through the left hand winding of relay 49 to ground. This impulse is opposite in sign to that which was previously trans-

mitted through the left hand winding of relay 49 and, consequently, energizes said winding differentially with respect to the locking winding of said relay so that the relay is de-energized. The de-energization of relay 49 closes a circuit in shunt with the winding of sleeve relay 56, from ground, over the back right hand contact of said relay, over the inner left hand front contact of relay 56, through resistance 111. This decreases the resistance over the sleeve contacts of jack AJ_1 and plug PN, thereby energizing marginal relay 57 to complete the circuit of the disconnect lamp 112. The toll operator at station N, in response to this signal, withdraws the plugs PN′ and PN from the corresponding jacks. The circuit through relays 64 and 65 in series is thereby opened so that the locking circuit through the lower winding of relay 68 and through the winding of relay 73 is broken at the lower contact of relay 64, thereby restoring the cord circuit to normal. The circuit of sleeve relay 56 is also opened by withdrawing the plug PN from the jack, so that the various relays associated with the line L_2 at station N are restored to normal.

Returning again to the situation existing after the toll operator at station N, in response to the glowing of the guard lamp 54 at the incoming operator's position, had extended the connection from the toll line L_2 over the toll cord TC′ to the toll switching trunk T′, it will be remembered that a signal comprising a code combination of three negative impulses, one positive and two additional negative impulses was transmitted to the station M, thereby operating lamp 105 to indicate that the called line is ready to be rung. In case the called subscriber's line had been found busy by the B operator, the toll switching trunk would have been plugged into a busy back circuit, which would result in intermittently connecting battery to the talking conductors of the switching trunk T′ in a manner analogous to that resulting from the flashing of the subscriber's switch hook. As a result of this connection, the relay 50 would be intermittently energized to transmit a succession of code combinations each comprising three negative impulses, a positive and two negative impulses, in the same manner as already described in connection with the flashing of the subscriber's switch hook. At the station M the relay 103 would be energized in response to a succession of these signals, thereby causing the flashing of the lamp 105. This signal coming before the signal indicating that the line is ready to be rung, indicates to the operator that the line is busy. The toll operator at station M is then free to take down the connection if she so desires.

Where the operator at the incoming position at station N has been unable to complete the connection to the called subscriber, either because the called subscriber is busy or for any other reason is not available, it is desirable that she should be able upon obtaining access to the called subscriber's line to establish the connection over the toll line in the reverse direction to the office at station M where the call originated, and in so doing should be able to signal the operator at the outgoing position, since such operator will be familiar with the details of the call. This result may be accomplished by inserting the plug PN of the toll cord TC′ into the outgoing jack OJ_0' at the station N. This operation results in completing a circuit from battery, through the winding of marginal relay 57, over the sleeve contacts of plug PN and jack OJ_0' at the station N. This operation results in completing a circuit from battery, through the winding of marginal relay 57, over the sleeve contacts of plug PN and jack OJ_0', through the winding of relay 113, over the upper back contact of said relay, through resistance 114 and over the right hand back contact of relay 58 to ground. Relay 57 being marginal is not energized over said circuit, but relay 113 is energized and locked up over its upper front contact in series with the winding of relay 58, which is also energized. Relay 58 at its right hand front contact completes a circuit for relay 53 which relay in turn, at its right hand front contact connects battery to the busy signals (not shown) included in conductor 61. Relay 58 in transferring its middle armature from its back to its front contact momentarily opens the circuit of the normally locked up relay 76. A circuit is now completed from battery over the back contact of relay 77, right hand back contact of relay 75, back contact of relay 60, middle front contact of relay 58, right hand back contact of relay 76, over conductor B′ and through the winding of relay G_2' and the right hand winding of relay H_2' to ground at the back contact of relay 79. Relays G_2' and H_2' are locked up and the former closes, at its outermost left hand front contact, a circuit over the conductor A′ to energize and again lock up relay 76. It will be noted that relay 113 is provided with two lower contacts which connect ground to conductors C′ and D′, respectively. Accordingly, when relay G_2' is energized it completes circuits over its three right hand contacts, through the windings of relays 1′, 4′ and 6′, respectively. These relays are energized and locked up, thereby releasing the transmitting distributor TD′ to transmit a starting impulse followed by a code combination consisting of a positive impulse, two negative impulses, another positive, another negative and a final positive impulse.

At station M the receiving distributor RD is set into operation by the starting impulse

and in response to the three positive impulses of the code combination, energizes and locks up relays 11, 44 and 66. As a result of this operation, a positive impulse is transmitted from positive battery, over the front right hand contact of relay 66, over segments 85 and 86, right hand back contact of relay 55, front right hand contact of relay 87, back left hand contact of relay 88, middle back contact of relay 89, left hand front contact of relay 90 and over conductor E and through the windings of polarized relay 114 to ground. The armature of polar relay 114 now makes connection with its left hand contact, thereby completing a circuit from ground, through the right hand winding of relay 91, over the armature of polar relay 114, through the winding of slow release relay 102 to battery. Relay 91 is energized and locked up through its left hand winding. Relay 102 is also energized and locked up, the locking circuit being traced from battery, through the winding and right hand front contact of relay 102 and over the left hand front contact of relay 91 to ground. A circuit is now completed from ground over the inner right hand front contact of relay 91, over the back right hand contact of relay 101, left hand front contact of relay 102, through lamp 115 associated with the answering jack AJ_o at the outgoing operator's position and thence over the left hand back contact of relay 116 to battery. The toll operator at station M in response to this signal inserts the plug PM in the jack AJ_o thereby energizing relay 116 to open the circuit of the lamp 115 at its left hand contact and apply battery to the conductor 20 leading to the busy signals (not shown). The details incident to the completion of the connection and the various signals transmitted will be similar to those already described and need not be further considered.

Where the call, originating at one station, such as station M, is to be completed over two or more toll lines in tandem, the toll operator at the originating station M will insert the plug PM′ of the toll cord TC in the jack J of the toll switching trunk connected to the calling subscriber's line and a plug PM of said toll cord into the outgoing jack OJ_t, which results in the actuation of a signal at the through operator's position at station N, as will now be described. A circuit is completed from battery, through the winding of marginal relay 14, over the sleeve contact of the plug and jack, through the winding of relay 117, resistance 16, to ground over the back left hand contact of relay 17. Relay 117 is energized and locked up over its front contact in series with relay 17, which is thereby engaged to complete a circuit of relay 19, as already described. Relay 17 at its middle armature momentarily opens a circuit of locking relay 21, thereby completing a circuit over the back left hand contact of said locking relay and the conductor B for the relays G_2 and H_2. It will be noted that relay 117 is provided with a lower contact whereby ground is connected to the conductor D. Consequently, relay G_2 over its first and second left hand contacts connects ground to relays 1 and 4, respectively, thereby energizing and locking up said relays. The transmitting distributor TD is now released to transmit a starting impulse followed by a code combination consisting of a positive impulse, two negative impulses, another positive impulse and two additional negative impulses. At station N the distributor RD′ is set into operation by the starting impulse and in response to the positive impulses of the code combination transmitted, energizes and locks up relays 11′ and 44′, which, in turn, complete circuits for the corresponding pyramid relays. A negative impulse is now transmitted from negative battery, over the back left hand contact of relay 66′, segments 47 and 48 of the distributor RD′, back left hand contact of relay 55′, front left hand contact of relay 42, back right hand contact of relay 43, middle back contact of relay 45 and right hand front contact of relay 46, over conductor E′ and through the windings of polar relay 118 to ground. Polar relay 118 in response to this impulse shifts its armature into connection with its left contact thereby completing a circuit from ground, through the left hand winding of relay 49, over the left hand contact of relay 118 through the windings of slow release relay 51 to battery. Relay 49 is locked up over its right hand front contact and through its right hand winding. At its inner left hand contact relay 49 completes a locking circuit for relay 51, from ground, over the inner left hand contact of relay 49 and over the right hand front contact of relay 51, through the winding of said relay to battery. A circuit is now completed by the relay 51, from ground, over the inner left hand front contact of relay 49, over the front left hand contact of relay 51, through the lamp 119 associated with the answering jack $AJ_t′$ at the through operator's position and thence over the back right hand contact of relay 56 to battery.

The glowing of lamp 119 apprises the through operator that a calling subscriber has been connected to the toll line L_2 and in response to said signal the through operator inserts the plug PN of the toll cord TC′ into the jack $AJ_t′$, thereby completing a circuit through the winding of sleeve relay 56 to open the circuit of the lamp 119 and apply battery to busy signals (not shown) in conductor 61. The through operator also inserts the plug PN′ in the jack $J_x′$ of a toll

line L_x' leading to another distant station where the connection is to be still further extended or else completed to a called subscriber's line. The jack J_x' may be an outgoing jack, leading to an outgoing, incoming or through operator's position at the distant station as the service conditions require. Assuming for simplicity that it leads to the incoming operator's position, a circuit is completed from battery, through marginal relay 65 and relay 64, over the sleeve contacts of the plug and jack to a sleeve relay 120 associated with the toll line L_x'. This relay operates in a manner similar to the relay 15 at station M to transmit a signal over a path, similar to the signaling path P, to the distant station.

When the connection has been completed at the distant station, the called subscriber's receiver being upon the switch hook, a signal will be transmitted over the signaling path to indicate this fact. This signal results in connecting a resistance 121, corresponding to the resistance 104 at station M, in shunt with the resistance of relay 120, thereby energizing the marginal relay 65. The circuit changes bringing about this result are similar to those already described in connection with the call from station M to station N. Upon the energization of relay 65, a circuit is completed from ground, over the front contact of said relay and through the winding of relay 122 to battery. Relay 122 at its extreme left hand front contact completes a circuit through the lower winding of the triple wound relay 68 in parallel with the winding of relay 73. Relays 73 and 68 are thereby energized and operate to disconnect the operator's set and to short circuit the splitting key 70, upper and middle windings of the relay 68 and the condensers, thereby eliminating the through operator at station N from any further duties in connection with the call except to take down the connection in response to a disconnect signal.

The energization of relay 122 also bridges battery across conductors 69 of the toll cord TC', thereby completing a circuit from battery, over the contacts of the splitting key 70, contacts of the ringing key 71, tip and ring contacts of the plug PN and jack AJ_t', contacts of ringing relay 72 and over the left hand contact of relay 49 to the winding of relay 50. The energization of relay 50 results in the transmission of a signal over the signaling path P, whereby resistance 104 is connected in shunt with the windings of relay 117, in a manner similar to that already described in connection with the relay 15. Accordingly, marginal relay 14 is energized to complete a circuit for the lamp 105, indicating to the toll operator at station M that the distant called subscriber is to be rung.

The toll operator at station M now actuates the ringing key 106 and transmits ringing current to the winding of ringing responsive relay 23. Relay 23 upon being actuated opens the circuit of locking relay 21, which is deenergized, and at the end of the ringing signal and upon the de-energization of relay 23 a circuit is completed from battery, over the right hand back contact of relay 25, left hand back contact of relay 24, right hand back contact of relay 23, middle front contact of relay 17, left hand back contact of relay 21, over conductor B and through the winding of relay G_2, the left hand winding of relay H_2 to ground at the back contact of relay 28. It will be again noted that ground is connected over the lower front contact of relay 117 to the conductor D so that relay G_2, upon being energized connects ground to relays 1 and 4 respectively. The energization and locking up of these relays results in the transmission of the same code combination as was transmitted to actuate the guard lamp 119; viz., a positive impulse, two negative impulses, another positive impulse and two additional negative impulses. As a result of the transmission of this code combination relays 11' and 44' are energized, thereby transmitting a negative impulse from negative battery, over the back left hand contact of relay 66', segments 47 and 48 of distributor RD', back left hand contact of relay 55', front left hand contact of relay 42, back right hand contact of relay 43, middle back contact of relay 45 and right hand front contact of relay 46, over conductor E' and through the windings of polar relay 118 to ground. Polar relay 118 again shifts its armature into contact with its left hand contact. It will be remembered that the relay 49 was energized and locked up in response to the negative impulse previously transmitted through the polar relay 118 and that, consequently, a circuit was completed from ground, over the right hand front contact of said relay 49 and over the back left hand contact of relay 63, through the winding of relay 62 and over the right hand front contact of relay 56 to battery. Relay 62 is therefore energized at the moment the present negative impulse is being received by the relay 118, thereby completing a circuit from ground, over the right hand front contact of relay 62, through the left hand winding of relay 63, over the left hand contact of polar relay 118 and through the winding of relay 51 to battery. Relay 63 upon being energized completes a circuit for the relay 108, over its left hand front contact, at the same time opening a circuit of slow release relay 62. Relay 108 closes a circuit for the ringing relay 72 and the relay 77 to apply ringing current over the contacts of the relay 72 during the period of time that is required for the slow releasing relay 62 and 108 to be de-energized. Relay

77, as before, prevents the de-energization of the locking relay 76 during ringing. The ringing current from the contacts of the relays 72 is transmitted over the talking conductors of the toll cord TC′ to a ringing responsive relay of the line L_x', similar to the ringing responsive relay 23 of the toll line L_2. The actuation of the ringing responsive relay of the toll line L_x' results in the transmission of a ringing signal over the signaling path associated with said toll line to the distant station, where ringing apparatus is actuated in a manner similar to that already described with reference to the toll line L_2 to transmit ringing current to the called subscriber's line. It should be noted that a different code combination was used to transmit the ringing signal in the case of the connection last described from that used in the case of connections established from the incoming operator's position, but that in both cases the same code combination is used for the ringing signal as is used for actuating the guard lamp. This enables the use of the same code combination to accomplish two different results, depending upon the circuit conditions at the time the code combination is transmitted.

When the called subscriber responds to the ringing signal, battery is disconnected from the toll switching trunk over which the connection was extended to his line, thereby causing the de-energization of a relay associated at the distant station with the toll line L_x', said relay corresponding to the relay 50 of the toll line L_2. This results in the transmission of a signal over the signaling path associated with the toll line L_x', whereby the shunt through resistance 121 is disconnected from about the winding of relay 120, thereby de-energizing the marginal relay 65, which in turn opens a circuit of relay 122, thereby disconnecting battery from the toll cord TC′. As a result of this action the relay 50 is de-energized, thereby momentarily opening a circuit of the locked up relay 76, which now functions to initiate the transmission of a code combination consisting of three negative impulses, a positive, another negative and a final positive impulse. At station M this results in sending a positive impulse over the conductor F, through the right hand winding of relay 91, thereby restoring said relay to normal, which operation results in opening the shunt through resistance 104 about the winding of relay 117. Marginal relay 14 is thereby de-energized and opens the circuit of lamp 105.

When the toll operator at station M receives the disconnect signal, the plugs of the toll cord are withdrawn, thereby de-energizing relay 117, which in turn opens a circuit of relay 17. Relay 17 in de-energizing momentarily opens a circuit of relay 21, whereby the same disconnect signal is transmitted over the signaling path P to the station N, as has already been described with reference to the connection involved in local lines at M and N only. The disconnect signal combination when received at station N results in transmitting a positive impulse over the conductor F′ to release relay 49, thereby connecting resistance 111 in shunt with the sleeve relay 56, so that marginal relay 57 is energized and causes the lamp 112 to glow. The through operator at station N upon seeing this signal withdraws the plugs PN and PN′ of the toll cord TC′ thereby transmitting a similar disconnect signal over the toll line L_x'. The toll operator at the distant station in response to the disconnect signal takes down the connection and the apparatus is now restored to normal.

The operations above described with reference to line L_2 are illustrative of the operations which take place in extending connections over any of the other lines of a group employing the same common signaling path, and it will be further understood that the operations above described in connection with the completion of a call in one direction over the toll line are the same as those taking place when a call is extended over the toll line in the opposite direction, since the apparatus at both ends of the line is the same. The only essential difference so far as the operations incident to the establishment of connections over various lines is concerned resides in the fact that different code combinations will be employed for different lines, and while the invention is not limited to any particular arrangement of code combinations, the combinations set forth in the following table have been found to be satisfactory where signals for 15 lines are transmitted over the same signaling path.

Line No.	Signals from outgoing to incoming end.				Signals from incoming end.		
	Guard and ring.			Disconnect.	To originating operator.		
	To inward operator.	To through operator.	To outward operator.	To completing operator.	Receiver on hook.	Receiver off hook.	Flashing.
1	5	15	156	56	5	56	5
2	4	14	146	46	4	46	4
3	3	13	136	36	3	36	3
4	2	12	126	26	2	26	2
5	45	145	1456	456	45	456	45
6	35	135	1356	356	35	356	35
7	25	125	1256	256	25	256	25
8	34	134	1346	346	34	346	34
9	24	124	1246	246	24	246	24
10	23	123	1236	236	23	236	23
11	345	1345	13456	3456	345	3456	345
12	245	1245	12456	2456	245	2456	245
13	235	1235	12356	2356	235	2356	235
14	234	1234	12346	2346	234	2346	234
15	2345	12345	123456	23456	2345	23456	2345

In the above table the numbers in the

first column indicate the numbers assigned to the lines and the numbers in the remaining columns the order of the positive impulses in each group of six.

It will be seen that by means of the apparatus above described a very flexible system for transmitting signals in connection with long distance lines has been devised, as well as a system which readily adapts itself to various service conditions.

It will also be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a signaling system, a first office and a second office, an incoming circuit terminating at said first office, a circuit outgoing from said second office, a toll trunk extending between said offices and terminating at a plurality of operators' positions at one of said offices, means at each operator's position for completing connections from said trunk to said outgoing circuit, means at said first office to complete a connection from said incoming circuit to said trunk, a signaling path extending between said offices, and means responsive to the establishment of a connection from said incoming circuit to said trunk at said first office to selectively signal over said path an operator at any one of the positions at said second office.

2. In a signaling system, a first office and a second office, an incoming circuit terminating at said first office, a circuit outgoing from said second office, a toll trunk extending between said offices and terminating at a plurality of operators' positions at one of said offices, an operator's signal at each position, means at each operator's position for completing connections from said trunk to said outgoing circuit, means at said first office to complete a connection from said incoming circuit to said trunk, a signaling path extending between said offices, and means responsive to the establishment of a connection from said incoming circuit to said trunk at said first office to selectively operate over said path any one of the signals at the operators' positions at said second office.

3. In a signaling system, a plurality of toll-trunks extending between two offices and each terminating at one of said offices at a plurality of positions, a signaling path common to said toll trunks and extending between said offices and means whereby an operator at the other office may selectively signal an operator at any position of any toll trunk over the common signaling path.

4. In a signaling system, a plurality of toll trunks extending between two offices and each terminating at one of said offices at a plurality of positions, an operator's signal at each position for each trunk, a signaling path common to said trunks and extending between said offices, and means whereby an operator at the other office may selectively operate any one of said signals over said path.

5. In a signaling system, a plurality of toll trunks extending between two offices and each terminating at one of said offices at a plurality of positions, an operator's signal at each position for each trunk, a signaling path common to said trunks and extending between said offices, means whereby an operator at the other office may transmit code combinations over said path, and means responsive to said code combinations to selectively actuate any one of said signals.

6. In a signaling system, a plurality of two way toll trunks extending between two offices and each terminating at a plurality of positions at each office, an operator's signal for each trunk at each position of each office, and means whereby an operator at either office may by establishing a connection to one of said trunks selectively actuate any one of the signals of said trunk at the other office over a circuit independent of the trunk itself.

7. In a signaling system, a two way toll trunk extending between two offices and terminating at a plurality of positions at each of said offices, signals at each of said positions, a signaling path independent of said trunk extending between said offices, and means whereby an operator at either office may by establishing a connection to said trunk selectively actuate a signal at any one of the positions at the other office over said signaling path.

8. In a signaling system, a plurality of two way toll trunks extending between two offices and each terminating at a plurality of positions at each office, an operator's signal for each trunk at each position of each office, a signaling path common to said trunks and extending between said offices, and means whereby an operator at either office may selectively actuate any one of the signals at the other office over said path.

9. In a signaling system a toll trunk extending from one office to a second office, supervisory signal apparatus associated with said trunk at the second office, another trunk extending from said second office to a third office, supervisory signal apparatus associated with said trunk at the latter office, means whereby the operator at the first office may control the supervisory apparatus at the second office for connections established between said offices over said first mentioned trunk, link circuit means to connect said trunks in tandem to establish connections between said first and third offices, and means whereby the operator at said first

office may control the supervisory apparatus at the third office on a tandem connection.

10. In a signaling system, a group of toll trunks extending from one office to a second office, supervisory apparatus associated with each trunk at said second office, a signaling path common to said trunks and extending between said offices, means whereby an operator at the first office may control over said common path the supervisory apparatus of any trunk at the second office, a second group of toll trunks extending from said second office to a third office, supervisory apparatus associated with each trunk at said third office, a signaling path common to said second group of trunks and extending between the second and third offices, means to establish connections between said first and third offices over any trunk of the first group and another trunk of the second group in tandem, and means whereby the operator at the first office may control the supervisory apparatus at the third office on any such tandem connection over said common paths.

11. In a signaling system, a toll trunk extending from a first to a second office, a second toll trunk extending from said second office to a third office, and terminating at a plurality of positions at said third office, a circuit incoming to said first office, means whereby an operator at said first office may connect said incoming circuit to said first toll trunk and signal an operator at said second office to connect said first toll trunk to said second toll trunk, means whereby said operator at the second office may signal an operator at any one of the positions of the third office, and means whereby the operator at the first office may signal to the third office independently of the operator at the second office.

12. In a signaling system, a group of toll trunks extending from a first office to a second office, a signaling path common to said trunks and extending between said offices, a second group of toll trunks extending from said second office to a third office, a second signaling path common to said second group of trunks and extending between said second and third offices, connecting means to connect any trunk of said first group in tandem with any trunk of said second group to establish connections between said first and third offices, means whereby signals originating with any trunk of the first group may be transmitted from said first office over said first signaling path to the second office, means associated with said connecting means for transferring said signals to a tandem trunk in the second group, and means whereby the transferred signal may be transmitted over the second signaling path to the third office.

13. In a signaling system, a toll trunk extending from a first office to a second office, a second toll trunk extending from a second office to a third office, a link circuit at said second office for connecting said trunks in tandem and for transferring supervisory signals from one trunk to the other, and means associated with said link circuit to connect an operator's set to said link, and means to automatically prevent the operator who establishes said connections from listening in by means of said connecting means or interfering with the connection after it is established so long as the link circuit is associated with the trunks.

In testimony whereof, I have signed my name to this specification this 9th day of December 1918.

JOHN DAVIDSON, JR.